ATTACHMENT J.4.63

H.C. NUTTING REPORT

REPORT OF

GEOTECHNICAL INVESTIGATION

SURROUNDING SILOS 1-4
PILOT PLANT VITRIFICATION FACILITY
FERNALD, OHIO

FOR

FERMCO
CINCINNATI, OHIO

1993

INVESTIGATION BY
THE H. C. NUTTING COMPANY

H. C. NUTTING COMPANY
EMPLOYEE OWNED
GEOTECHNICAL, ENVIRONMENTAL AND TESTING ENGINEERS
SINCE 1921

CORPORATE CENTER
4120 AIRPORT ROAD
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June 11, 1993

W.O. 14134.001 crk

FERMCO
P.O. Box 398704
Building 45
Cincinnati, Ohio 45239-8704

Attn: Mr. G. L. Francis, Senior Contracts Administrator
(Construction Acquisition Department)

**RE: Geotechnical Evaluation of Soils
Surrounding Silos 1-4
Pilot Plant Vitrification Facility
Fernald, Ohio**

Gentlemen:

We are submitting our report of geotechnical analyses in regard to the above referenced project. This work was initially requested by your RFP-110145, dated April 13, 1993, and performed in accordance with our proposal, dated April 21, 1993. The work was verbally authorized by Mr. G. L. Francis on May 28, 1993 and is conducted under your Purchase Order No. 5-35388.

The following paragraphs present descriptions of the project, scope of work, basis of information utilized for this study, a summary of subsurface conditions beneath the project site, and results of engineering analyses and geotechnical-related recommendations.

INTRODUCTION

PROJECT DESCRIPTION

The project consists of constructing a modular superstructure spanning over four existing unit four silos at the Pilot Plant Vitrification Facility. The four existing silos are numbered 1 through 4, as shown on the attached Figure 1. Silos 1 and 2 are identified as K-65 silos. Silo 3 contains metal oxide, and Silo 4 is empty, used for construction mock-up and system operability testing.

The new superstructure will carry waste removal and waste transfer systems. The superstructure will be supported by six new foundations with one foundation located adjacent to each of the silos (on their west and east sides). We understand that the proposed dead and live loading will reach as much as 200 kips, each.

Also associated with this construction will be some regrading of the existing earth berms surrounding Silos 1 and 2. Schematic drawings were provided to us describing the proposed work. These drawings are identified as CRU-4, Sketches C and D. A copy of each of these two drawings is attached for reference (Figures 2 and 3).

SCOPE OF WORK

This project included review of provided information and performance of engineering calculations in order to develop foundation design and construction recommendations. No field exploration nor testing of samples was conducted as part of this study. Provided information utilized for this study is itemized in the following section.

PROVIDED INFORMATION

The following information was supplied to H. C. Nutting for use in developing these recommendations. As stated, the study was to be completed utilizing only this information; no additional subsurface sampling or testing was to be performed.

1. CRU-4 Pilot Plant Silo Bridge Concept Drawing CRU4, Sketches C and D, dated April 5, 1993.

2. Exhibit B, Camargo Associates, Limited, Section V: Summary of Field Investigations and Section VI: Summary of Field Investigations. Also, Exhibit B, Soil and Material Engineer's Report of October 4, 1985: K-65 Silos, NLO.

3. OU4 Subsurface Soil Radiological Results and OU4 Subsurface Boring Logs.

4. Geotechnical Investigation Report - Pilot Plant Vitrification Facility, FERMCO, By ATEC, dated February 25, 1993.

5. Exhibit C, FERMCO Memo of February 3, 1993: "Determination of Source of Soil for K-65 Silo Berm". This reference includes Attachment 1: Field Compaction Reports by ATEC, dated 5/31, 6/7, 6/8, 6/10, 6/13, and 6/14/83.

6. Exhibit D, IT Certificate of Analyses, dated June 29, 1992. Note that this reference includes testing of 14 soil samples in berm material, but is apparently an area located away from the project vicinity. Therefore, as directed by FERMCO, this information was not utilized for this study.

7. Excerpt from a report, dated April 19, 1993, which includes testing of samples adjacent to Silos 1 and 2.

SITE CONDITIONS

GEOLOGY AND GENERAL SITE CONDITIONS

This facility is situated in an ancestral valley of the Great Miami River. This ancestral valley is approximately 2 miles wide at this location with the floor elevation of the valley being approximately 200 ft. beneath present ground surface. During glaciation of southwestern Ohio, this valley was subsequently filled with sand and gravel deposited by melt waters from the glaciers. Subsequent glacial advances periodically deposited glacial till on the surface of the sand and gravel. The till was eroded in variable fashion as the glaciers receded. Most recently, the surface was covered with water-deposited alluvium.

Topographically, the site generally has a ground surface elevation of about 575 to 580. The exception, is the area immediately adjacent to Silos 1 and 2 in the southern portion of the site. Here, an earth berm has been constructed around the existing silos, reaching up to about the top of the existing silos.

Based upon given information, the silo diameters are about 80 ft. and have a height of 26 ft. at their perimeter, reaching up to 36 ft. at their center. These are apparently reinforced concrete structures. The silos were reportedly constructed in 1955 and are supported on a 3.5 ft. wide and

3.5 ft. deep ring wall foundation. An allowable design soil bearing pressure of 4,000 psf was used.

The berm surrounding Silos 1 and 2 was originally constructed in 1964. The side slopes of this berm were evidently graded to a 1.5H:1V slope and subsequently experienced substantial sloughing problems. The berm was then regraded in 1983 to a 3H:1V slope, which apparently exists today. Note that some regrading of the berm is planned for the subject project, as discussed earlier, and shown on attached Figure 2.

The information supplied for this study included compaction testing during 1983 berm reconstruction. These reports covered six different dates between May 31 and June 14, 1983. The reports indicate that new fill was as deep as 24 ft. beneath finished grade. The reports submitted for review indicate that only part-time testing and inspection was performed and that the specified compaction was 90% of standard proctor, ASTM D 698.

Test boring data was supplied to us for review. Borings were conducted over various periods ranging from 1985 until the early 1990's. These borings included shallow borings into the berm materials surrounding Silos 1 and 2, as well as from surrounding grade. Subsurface conditions are described in the next section of this report.

SUBSURFACE CONDITIONS

The berm materials surrounding Silos 1 and 2 are reported to consist of a variety of cohesive soils with occasional granular layers. The predominate materials appears to be sandy clay fill with consistencies ranging from very soft to medium stiff. Occasionally, this fill contains gravel and organic material. Beneath the berm fill and outside of the berm perimeter is a crust of alluvial soils ranging from very soft to very stiff; however, the predominate consistency appears to be stiff. This material generally consists of lean clays interbedded with silts. Occasional sand lenses also exist.

Beginning at an average elevation of about 560 to 565 (or about 10 to 15 ft. below original ground) is a stiff to very stiff glacial till deposit. This material generally consists of a sandy silty clay or sandy clayey silt with varying amounts of gravel and rock fragments. Sand lenses are also occasionally interbedded within the till.

Beginning at an average elevation of about 545 to 550 is a medium dense to very dense granular stratum. This glacial outwash material consists of silty fine and fine to medium sand with varying amounts of gravel. This granular stratum extends to considerable depth (at least to elevation 500). For all practical purposes for this project, this granular stratum can be considered the "basement layer".

ANALYSES RESULTS AND RECOMMENDATIONS

SHALLOW FOUNDATION DESIGN

We understand that it is proposed to support the new superstructure on shallow foundations consisting of movable, precast foundations. The probable foundation size is reportedly 10'x16' or 10'x20'. At locations adjacent to Silos 1 and 2, it has been proposed to support these new foundations within the existing earth berm fill. Figure 2 illustrates that the preliminary foundation design elevation is 585, or about 10 ft. above surrounding natural ground surface elevation. This bearing elevation is also about 10 ft. above the existing silo base. These footings are planned 30 ft. outside of the perimeter of the existing silos.

Note that at Silos 3 and 4, shallow foundations are planned at minimum depth within the natural soils, or presumed to bear at about elevation 574.

Reported information on the berm fill at Silos 1 and 2 indicates a variable fill ranging from very soft to very stiff cohesive material containing sand, gravel and organics. The hammer weight used to drive the sampler was not indicated in the reviewed 1985 boring logs or report. Assuming a 35 lb. hammer was used during hand equipment borings performed in 1985, "corrected" equivalent Standard Penetration Test results in fill are estimated to range from about 6 blows to 20 blows per foot. This range of values indicates medium stiff to very stiff consistencies. Other borings indicated soft and very soft consistencies on numerous occasions.

Based on the berm soils containing "soft" conditions", an allowable shallow foundation bearing capacity of 1,000 psf is computed. Based upon provided loading of 200 kips per column and a precast foundation size of 10'x20', the resulting maximum contact stress would be 1,000 psf. Therefore, while some areas may reflect greater shear strengths, it is our opinion that the 10'x20' foundation size would be adequate and that these footings could bear as shown on the drawings, at elevation 585. For frost protection reasons, the footings should bear no less than 30" beneath finished grade.

The footings should be situated deep enough so as to avoid stress overlap on existing silo foundations. It is recommended that the new superstructure foundation be deep enough to result in an imaginary line of 2H:1V (or flatter) from the adjacent edges of existing and proposed foundations. At outside slopes, the new footing should be embedded sufficiently deep so as to have no less than 5 ft. of soil existing from the outside edge of the footing to the face of the slope.

Due to the potential of soft or very soft foundation soils and non-uniformity across the bearing surface, a specified uniform undercut beneath the footings adjacent to Silos 1 and 2 is recommended; details are provided in the next section.

At Silos 3 and 4, the anticipated bearing soils at minimum depth beneath present grade are at least stiff in consistency. Therefore, it is recommended that these new foundations bear on at least "stiff" natural clayey soils. The footings should penetrate through any topsoil or old fill. Also, the footings should bear at least 30" beneath finished grade. Due to the greater average soil shear strength here than at Silos 1 and 2, an allowable soil bearing capacity of 3500 psf is computed. Therefore, if feasible, a foundation size on the order of 8'x8' could safely support the 200 kip column load, instead of the proposed 10'x16' or 20' precast foundation size.

Settlement analyses were conducted for the proposed column load of 200 kips. For a 10x20 ft. foundation bearing in existing berm fill at Silos 1 and 2, a theoretical total settlement on the order of 1.5" is computed. At Silos 3 and 4, a total settlement of about 1" is computed for an 8x8 ft.

footing having a load of 200 kips. The computed settlement is on the order of 3/4" if the oversized 10'x16' footing is utilized at Silos 3 and 4, reducing contact stresses from about 3.1 ksf to 1.25 ksf. For all cases, about one-half of these given settlement values would apply if similar assumed footing sizes were used but applied loading was reduced from 200 kips to 100 kips. Note that most of this movement should occur as the load is applied. We understand that time-rate of settlement is not critical to this project and that some structural design accommodations are being made in anticipation of greater than normal settlements.

SHALLOW FOUNDATION CONSTRUCTION

It is recommended that at Silos 1 and 2, a uniform undercut be made beneath the base of the foundation. In order to provide a uniform bearing surface and accommodate any soft fill exposed at the base of the excavation, it is recommended that a uniform undercut of 24" beneath design bearing elevation be made. This undercut should extend 2 ft. outside of the design footing footprint as well. After undercutting, cleaning loose material, and approving the bearing surface, structural granular fill should be placed up to design bearing elevation. It is recommended that this structural granular fill consist of an ODOT 304 crushed stone. This material should be placed in 6" to 8" loose lifts with each lift being compacted to no less than 98% of maximum dry density as determined by the standard proctor method, ASTM D 698. The foundation can then be placed upon this new granular backfill.

At Silos 3 and 4, the footing can be placed directly upon exposed bearing soils, provided at least "stiff" natural clay soils are exposed. Note that boring No. 1 drilled in

1985 just southeast of Silo No. 3 encountered 5 ft. of fill underlying the ground surface. Therefore, if fill is exposed in any foundation excavations at Silos 3 and 4, it is recommended that the excavation be deepened to reveal natural soils having a stiff consistency.

In all cases, disturbance to the bearing soils after excavating should be minimized. The bearing surface should be cleaned of loose material, inspected, and approved prior to placement of either granular backfill (at Silos 1 and 2) or foundation concrete. The bearing soils should not be exposed for more than about one-half to one day before placing foundation concrete. Drainage should be maintained away from the foundations, both during and after construction.

LATERAL EARTH PRESSURE RECOMMENDATIONS

It is recommended that lateral earth pressures be based upon a total unit weight of 125 pcf, an active earth pressure coefficient of 0.3, and at-rest coefficient of 0.5. For passive resistance, an earth pressure coefficient of 2.4 is recommended. In the event of softening affects from wet/dry or freeze/thaw, it is recommended that passive earth pressure be neglected within a zone between final ground surface and 30" deep. An "ultimate" friction factor of 0.3 is also recommended. Note that the lateral earth pressure values given here are based on the assumption that relatively free-draining granular backfill is utilized and adequate backfill drainage is provided. Otherwise, hydrostatic pressures would need to be included. If any surface surcharge loads are applied, earth pressure calculations would need to account for this condition. Also, these earth pressure values are presented as equivalent fluid pressures having a triangular pressure distribution. The actual pressure distribution can approach more of a rectangular distribution and "at-rest" conditions when the wall is rigid and unyielding. Backfill compaction can also affect the pressure quantity and distribution. We can provide additional information upon request and being provided details on where lateral earth pressure design values are specifically needed.

SLOPES

All applicable OSHA regulations should be followed. "Temporary" excavation slopes shallower than 20 ft. can likely be made to as steep as 1.5H:1V. Some exceptions may occur if soft or very soft fill soils or granular lenses are exposed. Then, some sloughing may occur unless flatter slopes are utilized.

Figure 2 indicates that regrading of the existing berm around Silos 1 and 2 may involve placement of additional fill above the existing berm near its outer toe. In this case, any existing topsoil and soft surface soils should be stripped from the site. Prior to placement of any new structural fill, the existing materials should be benched to allow for placement of new fill on horizontal surfaces and also to "knit" the two fill materials together. New berm fill should be placed on stable, non-yielding surface and be compacted to at least 95% of standard proctor density.

Any "final" slopes involving cut or fill should be no steeper than 3H:1V. Slope stability analyses were made for "soft" berm soils assuming an average cohesion of 400 psf. This value is most likely conservative. Analyses showed factors of safety of at least 1.5 for a 3H:1V slope between Silos 1 and 2 and at outer slopes were footing surcharge pressures do not exceed 1000 psf.

CLOSING REMARKS

We appreciate the opportunity of providing these services to FERMCO. As mentioned, these recommendations have been provided based upon provided data only. Some variations may occur during construction from those described here. Therefore, we would be pleased to discuss any questions during the subsequent design or construction phases or this project.

Respectfully submitted,
H. C. NUTTING COMPANY

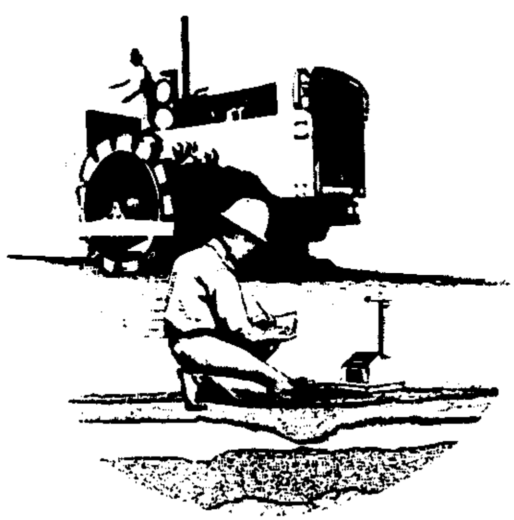
Jess A. Schroeder, P.E.
Principal Geotechnical Engineer

George C. Webb, P.E.
Vice President

Attachments

Appendix

Contents



LIMITATIONS OF LIABILITY

OUR WARRANTY

We warrant that the services performed by The H. C. Nutting Company are conducted in a manner consistent with that level of care and skill ordinarily exercised by members of the profession currently practicing under similar conditions. NO OTHER WARRANTIES, EXPRESSED OR IMPLIED, ARE MADE. While the services of The H. C. Nutting Company are a valuable and integral part of the design and construction teams, we do not warrant, guarantee, or insure the quality or completeness of services provided by other members of those teams, the quality, completeness, or satisfactory performance of construction plans and specifications which we have not prepared, nor the ultimate performance of building site materials.

SUBSURFACE EXPLORATION

Subsurface exploration is normally accomplished by test borings; test pits are sometimes employed. The method of determining the boring location and the surface elevation at the boring is noted in the report. This information is represented on a drawing or on the boring log. The location and elevation of the boring should be considered accurate only to the degree inherent with the method used.

The boring log includes sampling information, description of the materials recovered, approximate depth of boundaries between soil and rock strata and groundwater data. The log represents conditions specifically at the location and time the boring was made. The boundaries between different soil strata are indicated at specific depths; however, these depths are in fact approximate and dependent upon the frequency of sampling. The transition between soil strata is often gradual. Water level readings are made at the times and under conditions stated on the boring logs. Water levels change with time and season. The borehole does not always remain open sufficiently long for the measured water level to coincide with the groundwater table.

LABORATORY AND FIELD TESTS

Tests are performed in accordance with specific ASTM Standards unless otherwise indicated. All determinations included in a given ASTM Standard are not always required and performed. Each test report indicates the measurements and determinations actually made.

ANALYSIS AND RECOMMENDATIONS

The geotechnical report is prepared primarily to aid in the design of site work and structural foundations. Although the information in the report is expected to be sufficient for these purposes, it is not intended to determine the cost of construction or to stand alone as a construction specification.

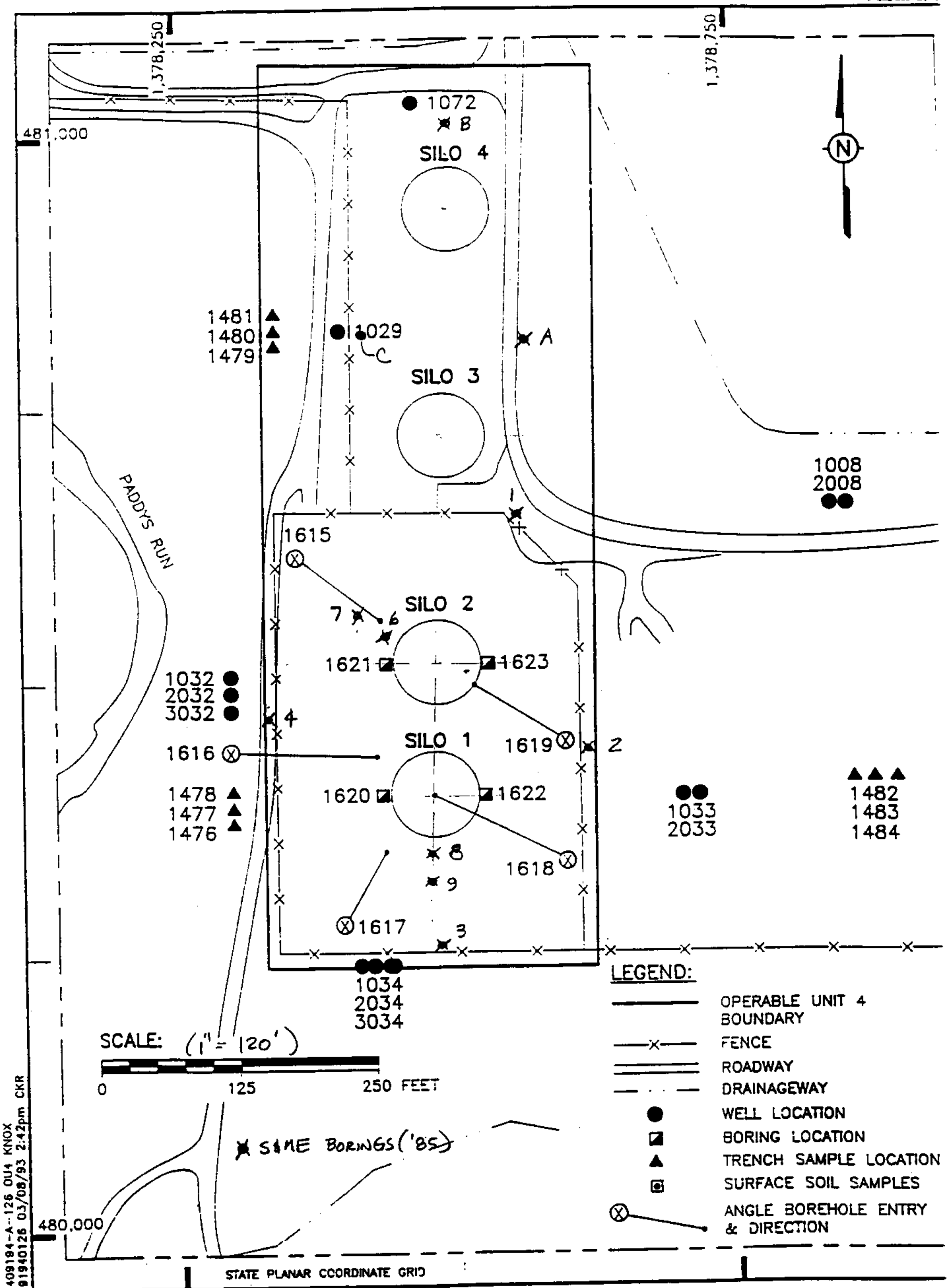
Report recommendations are based primarily on data from test borings made at the locations shown on a boring location drawing included. Soil variations may exist between borings and these variations may not become evident until construction. If significant variations are then noted, the geotechnical engineer should be contacted so that field conditions can be examined and recommendations revised if necessary.

The geotechnical report states our understanding as to the location, dimensions and structural features proposed for the site. Any significant changes in the nature, design, or location of the site improvements MUST be communicated to the geotechnical engineer so that the geotechnical analysis, conclusions, and recommendations can be appropriately adjusted.

The geotechnical engineer should be given the opportunity to review all drawings that have been prepared based on his recommendations.

CONSTRUCTION MONITORING

Construction monitoring is a vital element of complete geotechnical services. The field engineer / inspector is the owner's "representative" observing the work of the contractor, performing tests as required in the specifications, and reporting data developed from such tests and observations. THE FIELD ENGINEER OR INSPECTOR DOES NOT DIRECT THE CONTRACTOR'S CONSTRUCTION MEANS, METHODS, OPERATIONS OR PERSONNEL. He does not interfere with the relationship between the owner and the contractor and, except as an observer, does not become a substitute owner on site. He is responsible for his own safety but has no responsibility for the safety of other personnel at the site. He is an important member of a team whose responsibility is to watch and test the work being done and report to the owner whether that work is being carried out in general conformance with the plans and specifications.

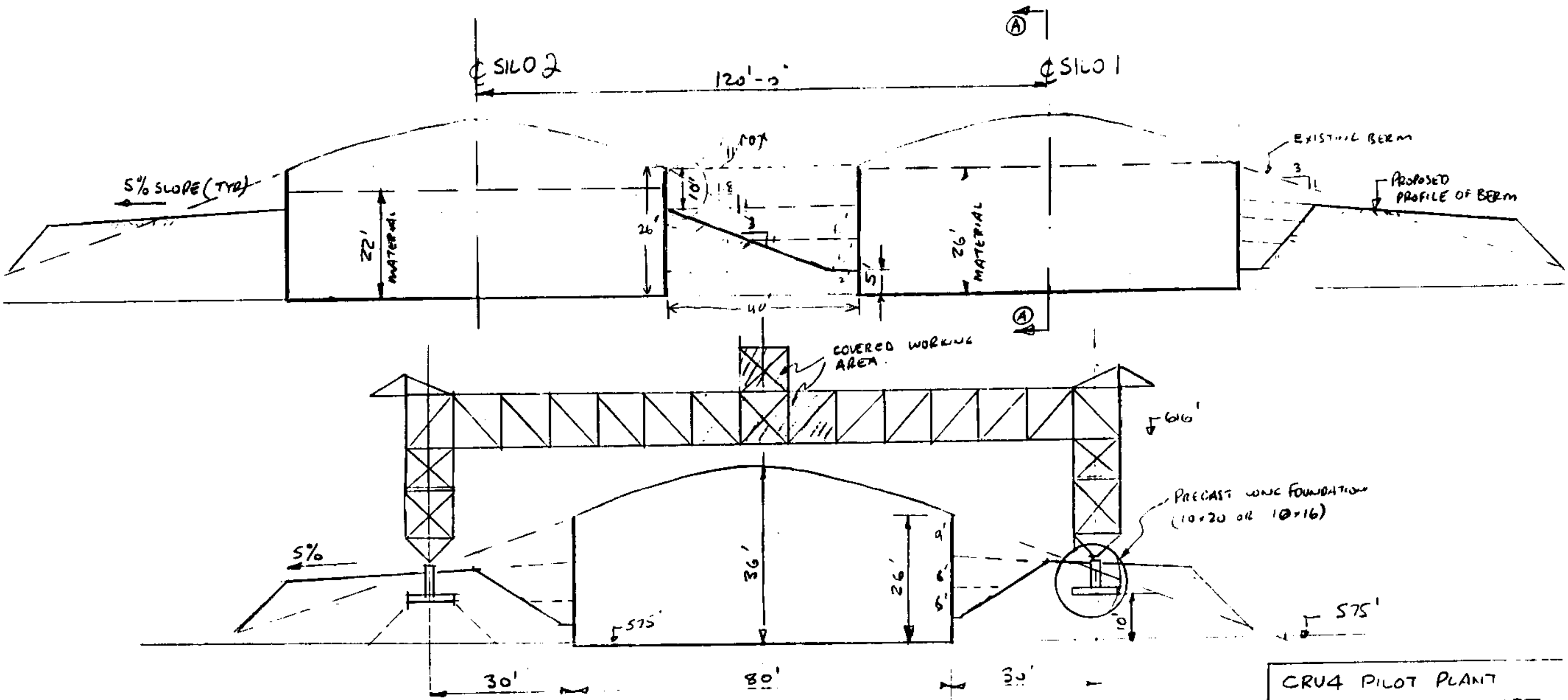


THE H.C. NUTTING CO.

FIGURE NO.: 1

W.O. NO.: 14134.001

OPERABLE UNIT 4 RI SAMPLE LOCATIONS
2-3



SECTION Ⓐ-Ⓐ

CRU4 PILOT PLANT
SILO BRIDGE CONCEPT
DRWG CRU4 - SKETCH D.
SCALE 1/20

DATE : 5 APRIL 93

PRELIMINARY

FERNALD ENVIRONMENTAL RESTORATION MANAGEMENT CORPORATION

REPORT OF

GEOTECHNICAL INVESTIGATION

SURROUNDING SILOS 1-4
PILOT PLANT VITRIFICATION FACILITY
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